THE TECH

Special Issue---Department of Civil and Sanitary Engineering

VOL. XXIX. NO. 63. BOSTON, MASS., SATURDAY, DECEMBER 11, 1909 PRICE FIVE CENTS

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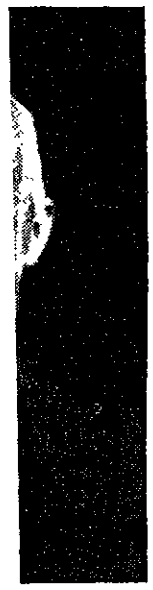

...PORTER.

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(Continued on page 5.)

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(Continued on page 9.)

(Continued on page 7.)

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Names Posted.

The names of officers of Technology organizations, are posted on the Institute Committee's bulletin board in the Union Social Room. Send corrections to Kerr, the Cage.

C. E. Society Dinner.

At the Union, Tuesday, Dec. 14, at 6.30 P. M., sharp, Prof. Fay will talk on "Causes of Failure of Structural Materials."

1910.

Class meeting Friday, Dec. 10, in Huntington Hall at 1 o'clock. Everybody come. 59,60,61,62

1911.

Ballots for the Junior Prom. Committee election were mailed yesterday. Any men who did not receive them at heir home address, will doubtless find them at the Cage. If not, ask Charlie for a ballot.

Remember that the polls close Thursday, Dec. 9, at 4.00 P. M. Don't forget to vote!

Third year Heat Problem Books have been returned and will be found on the table in the lower corridor in Walker.

1913.

Tickets for the 1913 Class dinner will be on sale at the Union between 1 and 2 today.. 59,60,61

Football team meet at Marceau, the photographer, 160 Tremont St., at 3.20 P. M. Wednesday, Dec. 15th. Bring football togs.

LOST.

At Gym Tuesday, Dec. 7, stick pin, bearing initials R. G. D. Will finder please leave at Cage for
R. G. DAGGETT.

1913 DINNER AND PIPES

The freshman class pipes have arrived and will be distributed at the dinner next Thursday evening There are many reasons for putting off the date of distribution until this time. In the first place, it is the opinion of many in the freshman class that the victory on Field-Day was never properly celebrated and it was suggested by some members of the 1913 class that the pipes be formally lighted on the night of the dinner. The committee in charge of the 1913 class pipes have reported a very small sale so far, due to the lack of interest of the 1913 men, or as somebody suggested, they are too young to smoke yet. The pipes cost $2.85 and $3.45 and are well worth the price asked. They are straight stem, B. B. B., round bowl, and are very attractive in appearance. So far only fifty have been sold among a class of 400 students. The committee has disbanded and further orders will be taken by N. Eichorn. The pipes will be given out at the freshman dinner.

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Long distance phone and hot and cold water in every room. Kept constantly clean by our vacuum plant. Rooms $1.00 a day and up.

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Consomme Juliette.
Fried Scallops.
Baked Stuffed Deep Sea Bluefish, a la Porto Rico.
Fricasee of Lamb, with Green Peas.
Veal Chops, Breaded, Tomato Sauce.
Boiled Corned Shoulder, with Spinach
Imported Frankfurts and Potato Salad.
Roast Ribs of Beef. Roast Venison.
Baked Macaroni, au Gratin.
Pastry or Coffee.
20 Cents.

THE TECH

Special Issue---Department of Civil and Sanitary Engineering

VOL. XXIX. NO. 63. BOSTON, MASS., SATURDAY, DECEMBER 11, 1909 PRICE FIVE CENTS

CIVIL ENGINEERING

By PROF. C. M. SPOFFORD.

The detailed descriptions printed herewith are sufficient to give to the student, about to choose an engineering course an accurate and clear conception of the subject matter of the purely professional courses in Civil Engineering. In order, however, that he may understand more fully the duties of the civil engineer and thus be better able to co-ordinate the relations of these various courses to one another, it is desirable to trace briefly the development of the profession and to show in a general way the character of the work which the civil engineer is called upon to perform.

Before the invention of the steam engine and the consequent tremendous development of manufacturing and transportation, there was little engineering and few if any professional engineers. Engineering in these days may be said to have been divided into two divisions, military and civil, the first, having to do with the construction of fortifications and military roads, and the latter, with the building of bridges, and the construction of the comparatively few water and sewerage systems. The scope of Civil Engineering at that time was well covered by the classic definition included in the charter of the Institution of Civil Engineers of Great Britain which is as follows: "The art of directing the great sources of power in nature for the use and convenience

PROF. C. M. SPOFFORD.

of man." The development of steam and electrical power and the consequent changes in methods of production and transportation broadened greatly the field of the civil engineer. It became increasingly difficult for one man to keep in touch with all its numerous developments and in consequence a gradual separation occurred. Mechanical, mining, and electrical engineering became established as well defined professions distinct from Civil Engineering.

Civil Engineering, however, continues to cover a broad field, and its lines are less closely drawn than those of the other engineering professions. To the civil engineer is still entrusted the location of highways and railroads, the construction of bridges and aqueducts, the design of water supply and sewerage systems, and the development of mines and harbors. In the conduct of nation and city he is ever becoming a more important factor, and upon his action depend the health and convenience of entire communities as well as the responsibility for the expenditure of great sums of money.

(Continued on page 5.)

HISTORY OF THE DEPARTMENT OF CIVIL ENGINEERING

By PROF. C. FRANK ALLEN.

The Course in Civil Engineering is one of the original courses provided at the Institute. Professor J. B. Henck, the author of Henck's Field Book, was the first, and for a long time, the only Professor of Civil Engineering here.

PROF. C. FRANK ALLEN.

In fact from 1865 to 1870, he carried on the instruction in Civil Engineering, to Civil, Mechanical, and Mining Engineers, practically alone, that is, without any permanent assistant. The field parties were in charge either of higher class men who had practical experience, or young graduates who happened to be available. The writer while a student assisted in this way. How it was possible for Professor Henck to do this work so well as it was done by him almost single handed, is still a marvel to some of his successors. The reputation of the Institute in Civil Engineering was early established by the men trained by him; while he never attained distinction in engineering work, he was an able man, very careful and thorough in his surveying work, a fine mathematician and a most excellent teacher, and his teaching brought results. No one in the early Faculty exerted as much influence as Professor Henck did in establishing the high, even rigid, standards of thoroughness which lie at the foundation of the Institute's reputation. Rankin's Civil Engineering which was used was practically the only available text-book on the subject; its training in fundamentals was grand.

In 1868, when the writer came here, the entire block opposite the Institute, from Berkeley to Clarendon Street, was vacant and was used for surveying and laying out curves; there was no loss of time going and coming for fieldwork. The entire section to the west of Clarendon Street was also unoccupied. The railroad survey of perhaps 1000 feet in length was made in the vicinity of the present Athletic Field in Brookline. Very early in the history of the Department, a plane table became a part of the equipment, and in 1869, Henry Mitchell, Professor of Topography, and Henry L. Whiting, Professor of Physical Hydrography, both associated with the United States Coast Survey, appeared in the Catalogue as part of the Instructing Staff. They did little of actual instruction here but doubtless influenced the work through their interest and advice. The 1869-70 catalogue recites that "the Instruction in Topography is mainly given in the field by means of the Plane Table, as perfected and used in the United States Coast Survey." The plane table thus early introduced has later, largely through the influence of Professor Burton who also had experience in the Coast Survey, become a characteristic feature of the instruction in Topographical Surveying. Few if any other colleges have appreciated its value sufficiently to develop it to the extent found here to be desirable. Certain Boston engineering firms who fully understand its use, are for that reason in demand in various parts of the country, to the writer's knowledge as far as Pennsylvania. From 1871 to 1876, Professor Henck was assisted by W. E. Hoyt, '68, afterwards Chief Engineer of the Buffalo, Rochester and Pittsburg R. R.

In 1881, Professor Henck resigned and his place was filled by Professor George L. Vose, who came from a similar position at Bowdoin College, and who was the author of "The Manual for Railroad Engineers," the best American treatise on the subject then existing. While he remained here only a few years, nevertheless during those years there were added to the department George F. Swain, Alfred E. Burton, and Dwight Porter, all of whom have afterwards become Professors and heads of departments or courses, and whose value to the Institute is well recognized. During no period of the same length in the history of the department has there been so valuable an accession. During his administration also, the work of the department had broadened and the need of specialization become apparent; the Sanitary work was assigned to Professor Porter, the Geodetic work to Professor Burton, and the Railroad work to Mr. C. D. Jameson, Instructor in Railroad Engineering.

When Professor Vose, an older man, resigned, Professor Swain was appointed as Acting Head of the Department, and not very long after, definitely its head. After graduation in 1877, Professor Swain spent three years in study abroad, not taking an advanced degree, but pursuing the studies he deemed most useful. He returned to the Institute, at that time probably the best equipped teacher of Civil Engineering in the country; his native ability was also of a very high order. His advancement to the Head of Department while still a young man was quickly justified. He was then giving the instruction in Structures and also in Hydraulics. About this time he received appointment as Engineer of the Massachusetts Railroad Commission, which yielded him unusual opportunities on the structural side, and this may have influenced him later to retain this line of instruction rather than the hydraulic work which was turned over to Professor Porter, whose work in Sanitary Engineering was closely allied to it. During the first year of Professor Swain's administration, three options were established for the Fourth Year, which were known as the General Course, the Railroad Course, and the Course in Geodesy and Astronomy. These were continued for many years and what is now called the Hydraulic Option and the Railroad Option are still maintained. This specialization had its beginning under Professor Vose and its fruition under Professor Swain. To what, if any, extent the influence

(Continued on page 9.)

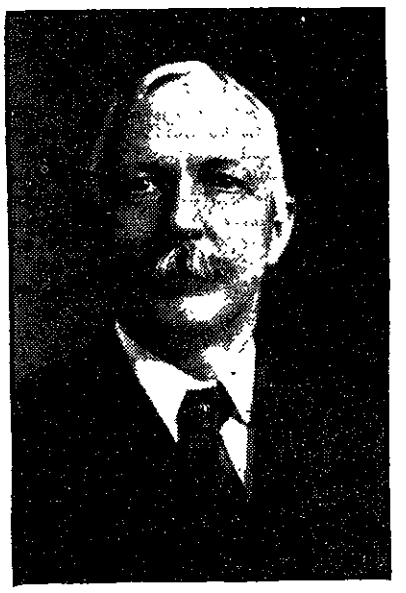
SANITARY ENGINEERING

By PROF. DWIGHT PORTER.

Assuming the profession of civil engineering to have been adequately defined, then sanitary engineering is to be thought of as simply that branch of the former which is concerned rather directly with the designing, construction and maintenance of works for the promotion of public health. In particular it is usually understood as dealing with projects for sewerage, drainage, sewage disposal, the furnishing of public supplies of drinking water and, if necessary, their artificial purification.

Numerous related questions are often referred to the sanitary engineer for solution, either alone or in co-operation with the chemist or biologist,—questions of preventing or lessening stream pollution, of the proper treatment of the garbage of large cities, of street cleaning, of house and school sanitation, and so on. The more common problems, however, are those first stated. They are of immense public consequence. Not only do they involve large expenditures of public funds, but they directly and seriously concern the health and comfort of the citizens, and the productive capacity of the great wage-earning class.

In large measure the technical knowledge, training and experience required in executing sanitary projects are much the same that are applied to various other civil engineering works. The great masonry dam on the Nashua river at Clinton is one feature of a



PROF. DWIGHT PORTER.

splendid scheme of public water supply, but it might equally well serve, and to some extent will serve, for the commercial development of hydraulic power. A pipe line is not necessarily different in the main feature of its design because it is to carry drinking water rather than water for turning turbines, and parallel statements might be made of many other works, and especially of many details of works classed under the head of sanitary engineering.

We naturally find, therefore, that many of our graduates from Course I. are, or have been, engaged upon projects of sanitary engineering, of which a notable example is seen in the great work under construction in the Catskills by the Board of Water Supply, of New York City, upon which a score or more of our men are employed, in positions of varying prominence from Chief Engineer downward. A similar statement could have been made with reference to our own Metropolitan Water and Sewerage works, and the Charles River

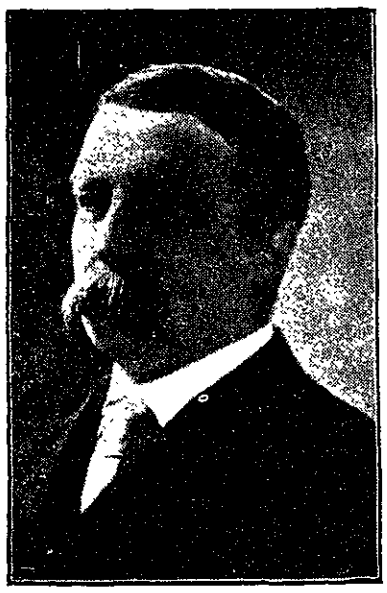
(Continued on page 7.)

C. E. SUMMER SCHOOLS

By PROF. A. E. BURTON.

The first Summer School in connection with the course in Civil Engineering at the Massachusetts Institute of Technology was held at South Deerfield, Massachusetts, in June, 1888. It was an optional school, open to all students in Courses I., XI., and XII., who had completed satisfactorily the third year work. There was no extra charge for tuition, and it was not a required subject for the general civil engineering student. It was, however, a part of the required course in the option in Geodesy for Course I., and for the geological students.

The main object of this summer course was to give actual practice to students in the field methods of carrying on a geodetic and geological survey. In addition to this a special week of instruction was given in Hydraulic Measurements. A base line was measured and a system of triangulation extended from it. A topographical map was constructed, with the special ob-



PROF. A. E. BURTON.

ject of showing the relation of the topographic form to the geological structure, and the flow of the Connecticut River was determined by several different methods of gauging. Eight students were in attendance. Professor Swain conducted the Hydraulic Measurements; Professor Niles gave the instruction in Geology; and Professors Burton and Porter carried on the geodetic and topographical work. This experimental Summer School was such a success that President Walker determined that it should be made a permanent part of the instruction at the Institute, and mention was made of it in the Catalogue of 1889. Until 1903 it was given every year to students who had completed the third year in Courses I. and XI. In 1903 second-year students were admitted on the payment of $25. tuition, and it was decided at this time to hold the school thereafter every other year. It has always been optional for the general civil and sanitary student. The total number of students attending these schools is two hundred and ninety-one; the average attendance at each school has been fifteen.

The last two schools, those of 1907 and 1909, were held at a camp on Rangeley Lake, Maine. In 1907 there were twenty-seven students in attendance. In the past the localities chosen for giving this field instruction were the Catskill Mountains, the Delaware Water Gap, the Adirondacks, Lancaster, Massachusetts, Lake Sunapee, N.H., and Machias, East Machias, Cherryfield, and Ellsworth, Maine. Detailed topographic surveys have been made at each of these sites.

It is the universal testimony of students and instructors that these optional summer schools in the past have been a great success, and that this success has been in a great part due to the conditions of living connected with the work. Instructors and students are thrown together in a way quite impossible under the conditions of Institute life in Boston; they are practically in camp together for four weeks

There is a plan now under discussion for placing all second and third-year field work in a required summer course of five or six weeks. To do this satisfactorily for one hundred or more students, who will then be in attendance, will require the establishment of a permanent camp, to be erected on some ground that has been selected for its adaptability for this work. Although no definite statement can be made in regard to the date of such a change in the course of instruction, it is pretty clearly evident that the plan is regarded favorably by the Corporation and the Department of Civil Engineering.

THE C. E. SOCIETY

By PRES. R. P. WALLER.

For some time previous to 1889 the men in the Civil Engineering Course at the Institute felt that much benefit would be derived if they could get some knowledge of practical work along with their theoretical studies. Accordingly, on Feb. 13, 1889, a few of the more energetic met in 21 Rogers Building for the purpose of forming a society to be known as "The Civil Engineering Society of the Massachusetts Institute of Technology" through which it was hoped, as the constitution says, "to awaken and maintain an active interest in the study of civil engineering among its members and to aid generally in their intellectual advancement and improvement." At this meeting the six Seniors and seventeen Juniors present got matters well under way; committees for framing a constitution and for consultation with the faculty were appointed and were to be ready to report on the following week.

At this second meeting, the minutes state: "President Walker spoke for twenty-five minutes. He was followed by Professors Swain, Burton, Allen, and Porter, whose remarks were also most interesting and valuable and created much enthusiasm among the students." From this time on the success of the society was assured, and well attended bi-weekly meetings were held throughout the year in the Rogers Building.

At these meetings papers prepared by the members on work they had been personally connected with were given, and not infrequently one of the professors or instructors of the Institute spoke to the society. This was the general character of the meetings, with now and then a practicing engineer called in to speak, till the spring of 1898, when a general agitation for a society banquet resulted in quite an elaborate affair at the Castle Square Hotel at one dollar a plate. This marked the formal acknowledgment by the society of a need for closer social relations between its members; and from this time increased attention has been paid to the development of this side of the society's activities.

The value of seeing problems being actually worked out was early recognized, and trips to various localities in the vicinity of Boston have been taken from time to time. Someone familiar with the work in question is secured to accompany the parties to point out the details which might be overlooked by the casual observer, and thus the excursions are made especially valuable. Individual trips by the students are also encouraged.

In addition to these dinners and excursions, meetings are held every few weeks which are addressed by some man of considerable experience in engineering who brings the work in the field nearer to the student than reading and study could possibly do. The desire to hear men of this character has grown of late to the exclusion of papers prepared by the members themselves. The Program Committee has not lost sight of that feature of the work, however, and in the near future meetings will be held in which the fellows alone are to take part. By the frequency and the informality of these gatherings it is hoped that a free discussion of all subjects will be indulged in by those present and that much value will be gained in this way.

Owing to the difficulty of securing speakers far in advance, a program for the entire year is next to impossible to arrange. However, a trip to one or two signal towers in the B. & M. R.R. yards, a lecture by Mr. Barber, and a dinner at the Union are the events projected for December. After mid-year's meetings will be held every third week if it is within the power of the program committee.

(Continued on page 8.)

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6 Beacon St., Boston.

R. M. LAWTON '03
Assistant Engineer, Grand Central Terminal,
New York City.

THE COURSE IN SURVEYING

By PROF. G. L. HOSMER.

While the subject of Surveying does not occupy such an important place in the curriculum as it did formerly, on account of the introduction of a large number of engineering subjects, yet its actual importance is only increased by this development of Civil Engineering. It is true that there are few engineers who devote the whole of their time to surveying; it is also true that there are few engineers who do not at one time or another have occasion to make surveys in connection with their engineering practice.

The course given to the civil engineers at the Institute is devoted chiefly to general methods of surveying. Special lines of work such as Underground Surveying, the U. S. public land system, hydrographic surveying and others, are all of great practical importance and deserve a place in any extended course. But the time allowed for this work is so brief that any attempt

PROF. G. L. HOSMER.

to teach specialties would be unsatisfactory. The instruction is therefore limited to the general methods which necessarily apply to all classes of surveying.

One of the advantages offered by a course in surveying is that it affords the student a means of practicing his profession during the vacation following this course. By continuing his course by means of summer work, the student not only acquires familiarity with the surveying and skill in its performance, but he also has an opportunity to view engineering work at close range, and to become interested in the practical details. In his later studies he will have a better grasp of the subject and a better appreciation of the relative importance of different parts of his work. Not the least important of the benefits to the student is the acquaintance he makes among engineers in practice.

Apart from the practical value of surveying, both as a part of civil engineering and as a means of making a start in the profession, there is a teaching value in surveying which should not be lost sight of. The field work not only has many of the advantages of physical laboratory work, i. e., manipulation of instruments, study of errors of measurement, keeping clear and accurate records, etc., but it also taxes the ingenuity of the student in overcoming practical difficulties. There is such a variety of problems and so many possible methods of solution that there is ample opportunity for the student to exercise his judgment and to develop originality in working out his methods of solution.

SANITARY ENGINEERING

(Continued from page 1.)

Basin project during their periods of active construction, as well as of various other enterprises of like character.

There is a class of undertakings, however, of somewhat recent development in this country, but of rapidly growing number and importance, the proper design and maintenance of which calls for more or less advanced knowledge of chemistry and bacteriology. Indeed, in the more important works, experts in these two branches of science must be consulted, and with them the designing engineer must co-operate. The works referred to are those of sewage disposal, works for preventing the pollution of streams by manufacturing wastes, and works for water purification. To fit a class of young men for effective service in these and related lines has been the main purpose in providing a special course in Sanitary Engineering, known here as Course XI., in which a substantial amount of chemistry and biology is provided, sufficient, it is intended, to fit the graduate to co-operate usefully with specialists in the design of sanitary works.

In most cases, though not always, the graduates of this course have gone into sanitary engineering practice, and a good idea of the field open to such men is afforded by a view backward over the successive classes and the various positions now held by their representatives. These comprise positions as assistant with prominent firms in private practice in Boston, New York and Chicago; others varying from that of Assistant to that of Chief Engineer with sundry state boards of health; positions as engineer, chemist or bacteriologist with sewage or water purification plants; engineering positions of various grades in city water and sewer departments, and with metropolitan and state water supply commissions; city health officers; profes sors of civil or of sanitary engineering; sanitary engineers in private practice; sanitary inspectors, etc.

There is no more fundamental or more generally useful branch of engineering than that classed as sanitary. The young man who enters it may expect to find a field for his highest efforts, and one in which he may be of great service to society.

HYDRAULIC ENGINEERING

By PROF. DWIGHT PORTER.

In so far as any engineer is concerned in a responsible way with the design or construction of works which have to withstand the pressure of water, or which are to convey, or measure water or to utilize it for power, navigation, irrigation and so on, he may properly be styled an hydraulic engineer.

The student of history who recalls the great aqueducts, reservoirs and canals built by the ancient Romans, Greeks, Egyptians and other peoples, will realize at once, then, that hydraulic engineering has long been practised, even though its early works were based upon a rather slender support of scientific knowledge. Even now our understanding of the physical laws which govern the flow of water is far from being complete and exact. Such as it is, however, it is to be acquired by the engineer from a study of the theory of hydraulics, a theory which must be supplemented for useful results by experience and experiment, the fund of which is forever being augmented.

The works in the intelligent design and carrying out of which the princi ples of hydraulics must play a part are of immense variety, however, including reservoirs, dams, gates, weirs, pipe lines, canals, tunnels, pumps, motors and other hydraulic machinery, stand pipes, purification works, locks, caissons, docks and a multitude of other structures. It is evident at once that they are too numerous and varied to admit of complete detailed study in the curriculum of any school, and that all that can fairly be attempted in any institution is training in the correct application of principles to the more common and typical structures, plus an incidental and moderate amount of teaching of allied features of practice. It is also evident that the success of many of the so-called hydraulic works mentioned is far more dependent upon correct knowledge of properties of materials and of the principles of structural and machine design than upon very complete knowledge of hydraulic laws.

Many graduates of the Institute are to be found in hydraulic engineering practice, those from the earlier classes as consulting engineers, and those from the later in the employ of private firms

(Continued on page 8.)

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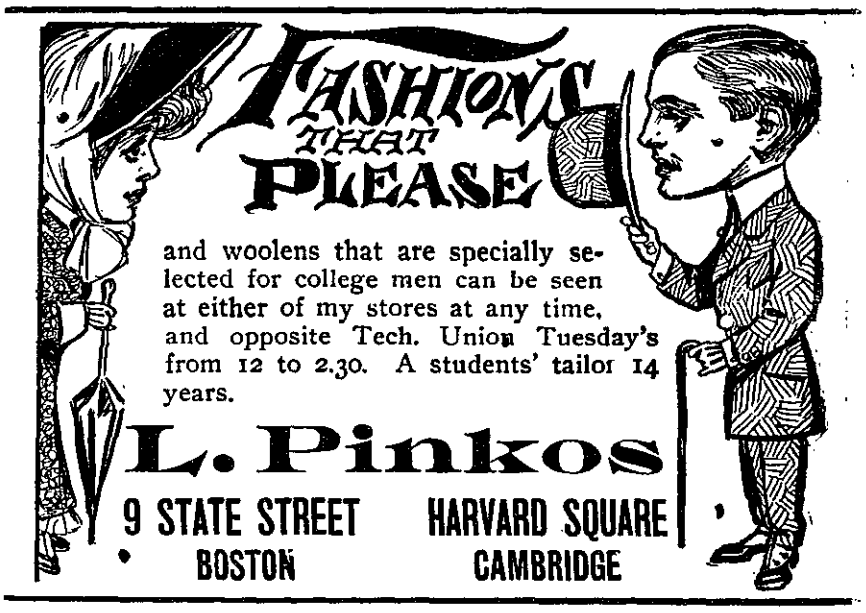
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GRADUATE WORK

By PROF. C. B. BREED.

While the regular four year course of instruction given at the Institute fits the young civil engineer for a favorable beginning in the practice of his profession and gives him the fundamentals of the common problems met in practice, still the student who has applied himself to a more extended study of his profession through a graduate year, as outlined in the advanced work given in Course I, is endowed with a distinct advantage over the ordinary graduate. Many of the vital problems which have been recently solved in studying the Additional Water Supply for the City of New York, in the investigation of the Quebec bridge and of the Blackwell's Island bridge, in the studies attending the design of the great railroad terminal and rapid transit problems of New York and Boston call for men especially trained in advanced civil engineering work. So important and so useful is the application of the training gained in the extra year that it is sure to

PROF. C. B. BREED.

pay good dividends on the investment of time and money given to it. Throughout this extra year the student gains a broader view of his professional work and at the same time acquires a more specialized knowledge of structures and of railroad, hydraulic and sanitary engineering. Those assistants in the civil engineering who teach these advanced subjects have found the year or two spent in this capacity most advantageous.

The advanced structural work is largely devoted to the study of statically undetermined structures. The study of flexure of structures, of stresses in draw spans, an exhaustive treatment of the arch, various methods of computing the elastic arch and other fundamental principles of advanced structural design are taken up.

The course in Contracts and Specifications treats of the essentials of contracts and the legal effects of various clauses, together with the forms used in advertising, letting and carrying out contracts.

Advanced courses are given in Railroad Engineering and Design and in Sanitary and Hydraulic Design. In the subject of Water Power, Irrigation, and River Works, advanced study in the flow of water in pipes, canals, flumes, and over dams is taken up and the testing and efficiency of turbines. Many typical existing municipal plants are studied in detail in connection with the subject of Water Purification and Sewage Disposal. A thesis is required which shall be of a more advanced grade than that required of the regular fourth year student.

Four years of training similar to that given at the Institute are necessary to prepare for this year of graduate work. Its standard is not like the graduate work given in many colleges, where it is required only that the student shall have graduated from some other recognized college to fit him to take an advanced course. Graduates from other colleges before they are properly fitted to enter upon this advanced course find it necessary as a rule to take two years of undergraduate work at the Institute, in the civil engineering department. Twenty-six per cent of the present senior civil engineering class are college graduates.

C. E. SOCIETY

(Continued from page 2.)

The society has grown from the small number of twenty-three present at the first meeting in 1889 till now, practically all of the fourth and third year men, and many second year men enjoy the privileges of its membership, some two hundred or more names being on the roll last year. Owing to the fact that the ground covered during the year is of lasting value to every member in the course, the eligibility requirements are restricted to a nominal fee, and the signing of the constitution, so that any one so desiring can become a member. The society's large membership and its hearty endorsement by the faculty are evidences enough of its worth and of the place it is filling in undergraduate life at the Institute.

HYDRAULIC ENGINEERING

(Continued from page 7.)

of engineers or contractors, or on municipal, state or national works. Several are in the Corps of Civil Engineers of the Navy, a considerable group in the Reclamation Service, and with the Board of Water Supply of New York, at the head of each of which great undertakings is an Institute graduate; and if the foremost hydraulic engineer of the country at the present time were to be singled out there is little doubt that he would be found to hail from M. I. T.

RAILROAD ENGINEERING

By PROF. C. FRANK ALLEN.

The importance of Railroad Engineering as a branch of Civil Engineering may be gathered from the fact that a count made a few years ago indicated that about one quarter of our graduates in Civil Engineering are engaged in railroad engineering; and a similar canvass of the members of the American Society of Civil Engineers made a like showing. In view of the fact that a very considerable part of the bridges built are needed in connection with railroads or with electric railways, the real importance of the railroad in creating opportunities for the employment of Civil Engineers becomes manifest. Aside from the pure engineering work, many of the railroads are coming to depend more and more upon graduates of engineering colleges for the executive positions to be filled. The railroad superintendent or manager can far better administer his duties if he has a clear knowledge of the behavior of materials such as may be acquired from the study of Applied Mechanics; and of the laws underlying power and its use, such as he may acquire from studying Steam Engineering, Hydraulic Motors, and Dynamo Electric Machinery. On some of the best handled railroads such men are sought for advancement and promotions to the higher positions made from among them; better methods of organization are adopted when men of this sort are available. There is not room here to discuss the question whether executive ability is a gift or is partly acquired.

It is not the training in railroad curves or in any such special lines that makes the successful railroad man; it is the all-around training such as the Institute offers and of which the purely railroad instruction, to be sure, constitutes a part, and it may reasonably be claimed an important part. In fact a considerable portion of the work given under the name of railroad engineering in the third year is more properly denominated Location, and is useful, or rather necessary, for running in pipe lines, conduits, sewers, streets and roads and for various purposes. The writer was once called to take charge of reservoir construction, in part and perhaps largely because the engineer previously in charge felt himself incapable of laying out a short curve for laying pipes. In Sanitary Engineering, in Highway Engineering, in fact, in almost any line of engineering work, the principles involved are likely to confront one.

One is inclined to think that a large part of the railroad system of the country is already constructed, and yet from time to time important long lines are projected like the Western Pacific, or the Grand Trunk Pacific, requiring trained locators. Aside from this there are constantly in progress revisions of line involving re-location, so that the principles of location cannot be relegated to the rear as a lost art. The interurban electric lines are also multiplying and they too demand skill in location. Then, maintenance of way is a constant problem, with unsolved elements appearing with frequency. Railroad signaling, again, is almost in its infancy. The changes and the progress in signal work are so marked that even the specialist, the signal engineer, is hard put to it to keep pace with what is doing. A side line of work which will require much attention in the near future (in fact already to a considerable extent) is the abolition of grade crossings, involving also all sorts of engineering, including especially sewerage, and drainage and also highway engineering to some extent. In the department, this feature of railroad engineering has proved definitely attractive to the teaching force, and every year some project for separation of grades is selected for Thesis.

Another subject which attracts the teachers of railroad engineering is the arrangement of yards for sorting, storing, loading and discharging cars. Much progress has been made in late years in designing important handling yards, but much wastefulness of effort and much congestion of traffic is constantly occurring in less important yards, not really designed at all, but which like Topsy have "just growed." Thesis work in this line has not been uncommon and station and yard design is selected as one of the subjects to receive additional attention in the advanced courses.

Another subject which has attracted much attention for the last twenty years especially, is the Economic Theory of Railroad Location, in which an effort is made to trace the effect upon a straight and level line, such as additional "distance," or the introduction of "curvature," or the use of steep "gradients." Somewhat extended attention is given in the course to this subject, which is a vital one in the revisions of line and grade which become necessary from time to time, not always because the earlier work was faulty, but oftener because new conditions of traffic make a new alignment or grades justifiable because now more economical. The writer is in a position to believe that important changes are likely to soon come about in the basis for the allowance to be made for such items, and the study is of considerable interest. Those engaged in teaching railroad subjects at the Institute are at present in good position to keep pace with such changes.

Specialization in railroad instruction, or any specialization is often looked at askance by educators and with good reason. Nevertheless, so far as the specialization is accomplished without the sacrifice of fundamentals, and so far as the instruction given contains the proper elements of training value, the specialization is likely to prove profitable. A constant danger in all education is that it may scatter in the effort to secure breadth; there is often more danger of failure from neglecting to secure depth than there is of securing proper breadth. The work in railroad engineering is arranged with a definite purpose to avoid just cause for criticism upon this point.

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CIVIL ENGINEERING

(Continued from page 1.)

To enable him to properly fulfill these responsibilities, his education should be thorough and broad. To that end he is first taught the fundamental sciences of mathematics, physics, chemistry, and mechanics, in order that his professional subjects may have a secure foundation. The professional courses described in this publication follow. The aim in these is to thoroughly drill the student in the underlying principles of the profession, which if he does not learn in college he can acquire only by arduous and time-consuming labor in later life. Enough attention is given to the details of practice to show him their importance and to give him some idea of the point of view of the practicing engineer; but it is realized that if he possesses a well-trained mind and is thoroughly familiar with the principles upon which good practice is based, he can acquire the necessary knowledge of the continually changing details of practice far better after leaving college.

In addition to scientific and professional courses he is also required to give considerable time during the first three years of his course to general subjects such as language, history, and economics. These subjects are considered to be of no less importance than the other courses in fitting the young man to become a leader in his profession, and no student should enter upon the study of civil engineering without a thorough realization of the necessity of adding to his scientific and professional training that ability in the use of the English language and that knowledge of human life and thought without which he will be unable to assume the highest responsibilities and duties.

STRUCTURES AND BRIDGE DESIGN

BY PROF. C. M. SPOFFORD.

The subject of Structures deals with the application of the principals of mechanics to the design of engineering structures such as bridges, roofs, dams, and retaining walls. It is the longest professional course given to civil engineering students and extends from the beginning of the second term of the junior year to the end of the senior year, with three hours per week of exercises for the first year, and five hours per week for the last half-year. To its allied subject, Bridge Design, there is also allotted six hours per week for the entire senior year. In addition to being the longest course, it is also one of the most fundamental subjects taught in the Department, since no matter into what branch of Civil Engineering the student may enter he is sure to find himself called upon to deal in some capacity or other with some of the structures considered in the course, and must have a thorough knowledge of the principles upon which their design is based.

The undergraduate course opens with a comprehensive study of the magnitude and character of the forces to which ordinary structures are subjected, such as locomotive and cars, snow, wind, and crowds of people. The effect of these loads upon beams and girders are next considered and the student is taught to design these simple structures. This is followed by an extensive treatment of simple bridges and roof trusses.

The more complicated structures, such as suspension and cantilever bridges, arches of steel, stone or concrete, and steel-frame buildings are treated less thoroughly than the simpler structures, but sufficient attention is given to these to outline the methods required for their design. Earth pressure and its effect upon retaining walls and the principles underlying the design of such walls and of masonry dams are also carefully considered. The problems which are included in the course and which are carefully corrected before returning, form an important portion of the work. These are planned to develop originality in the application of fundamental principles to unfamiliar types of construction.

In the parallel course of Bridge Design the student is required to make all the computations necessary to determine the size of the members of at least two trusses, and of one girder bridge, and to make careful drawings to scale to show

(Continued on page 6.)

INSTRUCTING STAFF

(Continued from page 4.)

and afterwards as Mechanical Engineer, with the American Tin Plate Company, following his graduation from the University of Wisconsin. After leaving the Institute he was employed in the engineering department of the Phoenix Bridge Company for a year and a quarter. He has also been connected with the engineering departments of the Illinois Central Railroad at various times as follows: in the road department, bridge department, and construction department, the latter being on heavy concrete work in connection with track elevation in Chicago. He spent one summer in the engineering department of the Western Electric Company and one in the office of the superintendent of the Bucyrus Steam Shovel Company's plant.

For the past two years he has been assistant engineer of bridges for the Massachusetts Railroad Commissioners and has been engaged in consulting work on bridges and foundations.

He is connected with the following societies: American Society of Civil Engineers, Webster Society of Engineers, Boston Society of Civil Engineers, Society for the Promotion of Engineering Education and the Technology Club.

Harold K. Barrows, S. B., who has just been appointed Associate Professor of Hydraulic Engineering, is a graduate of the Class of 1895, of Technology. During the following years he held the position of Assistant in the Civil Engineering department and since then has spent most of his time in professional work.

When he left the Institute in 1896 he entered the office of the City Engineer of Newton, remaining there for about

PROF. HAROLD K. BARROWS.

three years, during which time he held positions as transitman, masonry inspector and chief of party. After this Mr. Barrows spent two years with the Metropolitan Water Board in Boston as designer and computer, and had much to do with the designing of the Forest Hills Reservoir and Weston Aqueduct.

Mr. Barrows spent a year as Assistant Professor of Civil Engineering at the University of Vermont.

Since 1903 Professor Barrows has been an engineer of the United States Geological Survey and has been in charge of the hydrographic work in New England and New York. He has also been engaged in private practice for several years as consulting engineer. In this capacity he has conducted investigations and made reports on several water power projects and other hydraulic work, and has engaged in some construction work along these lines.

The professional societies to which Professor Barrows belongs are: the American Society of Civil Engineers, the Boston Society of Civil Engineers, the New England Water Works Association and the Society for the Promotion of Engineering Education.

The men in this department ranking as Instructors at the present time are Mr. Howard and Mr. Bradbury.

John W. Howard, S. B., graduated from the Institute in the Class of 1903 and during the next two years was Assistant in the Civil Engineering department. In 1905 Mr. Howard was made an Instructor. He has done a great deal of surveying for private parties in spare time and during the last five summers has been on the Massachusetts State Survey on town bounds. Mr. Howard has worked for the Pennsylvania R. R. on double-track work and at another time was on the original committee which investigated the New York water supply.

Royall D Bradbury, S. B., graduated with the Class of 1906. He was made Assistant the following school year and since 1907 has been an Instructor. Mr. Bradbury spent one summer as rodman on the Chicago, Rock Island and Pacific R. R. and another as draftsman with the Kansas City Bridge Co. He has also been draftsman for the A. M. Blodgett Construction Co. of Kansas City. At the present time Mr. Bradbury is engaged as consulting engineer for the Boston Elevated on the safety of bridges. He also does work for the Boston Consolidated Gas Co., Edison Electric Light Co. and others. Mr. Bradbury is also engaged in conducting a course in Concrete Engineering at the Boston Y. M. C. A. School .

In the department of Civil Engineering there are eight men ranking as assistants whose work is to take charge of and instruct the small parties of from three to six men sent out for field-work in second and third year surveying, hydraulic measurements, etc. They are also called upon to assist in the hydraulic laboratory and the drawing-room work in stereotomy.

The assistants at the present time are H. B. Alvord 1907, H. B. Luther 1908, R. L. Cary 1909, W. W. Clifford 1909, F. R. Faulkner 1909, F. S. Lovewell 1909, M. W. Rew 1909, and A. L. Shaw 1909.

CURRICULUM OF THE COURSES

Throughout the first year work at the Institute is practically the same for all courses. During that period general training is given in Mathematics, Drawing and Inorganic Chemistry, which are fundamental as preparation for the work of the succeeding years. The work in Chemistry includes lectures, recitations and laboratory periods. The work in Mathematics comprises a study of advanced algebra, the elements of Plane Analytic Geometry and Differential Calculus, and Plane Trigonometry, including the use of Logarithms. In addition to courses in Freehand and Mechanical Drawing, instruction, comprising lectures and drawing-room exercises, is given in Descriptive Geometry, which deals with the projection of points, lines and planes in space.

At the beginning of the second year, division into the various courses takes place. Training in Mathematics and Descriptive Geometry, including a study of Warped Surfaces, is continued in both the Civil and Sanitary Engineering Courses. The work in Mathematics includes instruction in Solid Analytic Geometry, Differential and Integral Calculus. Work in Physics, comprising lectures, recitations, and laboratory periods, is instituted and continued into the third year. The subjects covered are Mechanics, Wave-motion, Electricity, Optics and Heat. Practical work is introduced in the shape of field exercises in Topographical Surveying, including instruction in the use of the chain, tape, compass, solar compass, transit and level. With the opening of the second term, work is commenced in Applied Mechanics, comprising a study of static forces, stresses in frames, centers of gravity of various bodies, moments of inertia, laws governing rectilinear and curvilinear motion, work, power and energy.

The separation of the two courses is not very marked during the second year. With the exception of a short course in Spherical Trigonometry, the students in Sanitary Engineering cover all the work in the Civil Engineering Course, and in addition further pursue the study of Inorganic Chemistry in Qualitative and Quantitative Analysis of known and unknown substances.

During the third year, in addition to more advanced work in Topographical Engineering, courses are instituted in

(Continued on page 6.)

PROM ELECTIONS

HOWARD DAVID WILLIAMS
SCOTT PRESCOTT KIMBALL
RICHARD HARTSHORN GOULD
GORDON BALL WILKES
PETER DESMOND WHITE

There was great enthusiasm when the result of the Junior Prom election was anounced last night at the 1911 banquet. Every man on the committee is prominent in class and Institute affairs.

H. D. Williams has been manager as well as a player on the class foot-ball team, was secretary of the class last year, a member of the Technique Electoral Committee and has shown active interest in athletics generally. Williams received the highest number of the total 127 votes; his vote was 81.

S. P. Kimball, vice-president his first year, was elected to the Technique Electoral and Institute Committees last year. He received 56 votes. R. H. Gould, who has been prominent in athletics, was also on the Technique Electoral Committee. His vote stood at an even half-hundred. P. D. White and S. B. Wilkes, were very close, Wilkes received 47 and White 46 votes.

Following is the list of the other nominees, named in order from the highest down; E. A. Nash, 43 votes; L. G. Fitzherbert and J. A. Urquhart tied with 37 votes; M. A. Grossman tied with S. B. Putnam with 32 votes. C. F. Hobson, 31 votes; C. R. Perry, 24 votes; Kester Barr and W. H. Coburn received 23 votes each; C. R. Johnson had 22 votes; S. H. Cornell 19 votes and George Watson 17 votes.

UNION ENTERTAINMENT

"No man is self-made," said Mr. Lucius Tuttle, president of the Boston & Maine, last night at the Friday Evening Entertainment. "A man who has absorbed assistance from every one who can give him assistance, may be called a self-made man but, he has really only made the most of the help of others." Mr. Tuttle emphasized the fact that the young men, especially the educated young men of to-day, are to carry on the business of the next generation and of the next decade. Education will train thought, and thought will train leadership—either for good or evil.

Mr. Tuttle urged the men to cultivate the powers of observation, analysis, and deduction. "Learn the Why," he said, "Therein lies the most valuable asset of the man who is educated." These powers by developing a fund of experience, help one to decide promptly. The successful man is seldom the honor man at college, but rather the patient plodder who is able to make quick decisions—one who has not the paramount ability of guessing but rather, the paramount ability of quick judgement. It is better to make one mistake in a hundred, because of hasty decisions than to lose valuable time over every decision. There are only 24 hours in one day—make the most of them.

Be thrifty. Money is not the "root of all evil" although the improper love of money is. Mr. Tuttle said that its proper use is the "root of all success" and never has money been used with such success as in the United States to-day.

Be clean morally and physically. "A good hot bath cleans a man's conscience better than anything else."

Mr. Tuttle then spoke of cynicism. A pessimist has been epigrammatically defined as the wife of an optimist. This may be true, he said, but don't be a pessimist, because there is more good than bad in the world and cynical man needs praying for.

One of the greatest assets a man has is the ability to handle men and demonstrate to them that it is to their own best advantage to follow. This is a bigger problem than engineering.

The immigration question calls for serious consideration. Ignorant hordes are daily coming to this country attracted by the promise of liberty, which they construe as license.

In conclusion, Mr. Tuttle said, "Don't get impatient and don't expect to begin where your grand-daddy left off.

After the lecture, Gorton James 1910, chairman of the Entertainment Committee, announced for the Union Committee that no more refreshments will be served after the entertainments since only one has paid expenses this year.

LETTERS FROM GRADUATES

(Courtesy of Prof. C. M. Spofford.)
Tientsin-Pukow Railway, China.

I have been out here for about two years now. The first year, I was up in Tientsin at the University trying to teach the youth of China something of mechanics, railroad work and structures. The courses given there now are in Civil Engineering, Mining Engineering and Law. On paper, at any rate, they would look as well as almost any courses anywhere.

Before entrance the student is supposed to have completed his study of physics, chemistry, mathematics (including calculus), and all other subjects not strictly technical. The courses there are for three years, the first class completing the revised course of study graduating next year. The institution went to pieces entirely during the Boxer troubles and is now just getting fairly on its feet again. On the whole, I believe that the University will do a big work in time but it will require time to prepare suitable conditions for it to grow to its full height in. The great difficulties now are a lack of students with proper preparation, there not being enough teachers or money here to properly man the primary and secondary schools for them to act as satisfactory feeders. Another difficulty is that, in order to command the respect of the Chinese, the students must have been well educated along Chinese lines and that is a task of many years in itself. This brings the students to the University at too great an age and after undergoing a long course of training tending to cause their minds to set. These difficulties are gradually being overcome and it ought not to be many years before the Chinese Universities can take rank with those in Japan if the Government will only maintain the policies it has begun and then improve on them as fast as it knows how. Taking account of the very great handicaps that the Chinaman suffers under, both through his national history and religion and social and economic conditions, and through the character of his own individual training, most of us admit that he does remarkably well when he has to. The latter thing is the important one—to get them so that they want to and have to.

But so much for a long-winded discussion of the educational situation. I found Tientsin in some ways to be a very pleasant place to live in. The great thing that gives life its peculiar features to a newcomer, particularly an American, is the cheap and fairly efficient supply of servants so that everyone can keep up an establishment that would require a very good financial standing at home. Bachelors can especially appreciate the advantages since they can start up housekeeping by simply hiring the "boy" and thereafter doing nothing but paying the bills. A competent boy can be gotten for about five dollars or a little more a month. Of course he requires a force of assistants but their pay is in proportion and they are supposed to feed themselves, though the way food disappears leads one to believe that this supposition is honored more in the breach than in the observance.

I came down here a year ago. The railroad is also a Government affair. The bonds were underwritten by a British-German syndicate and so the line was divided into two sections. The northern end, in Shantung, where the Germans hold forth mainly, is being built under a German Chief Engineer and Germans and German products generally have the inside track.

Down here it is the British. The Chinese Director on this end was educated in America, however, and so he insisted on running in a few Americans.

For the first eight or nine months I was here, I was engaged in running the preliminary survey, using the stadia method throughout. Since then I have been on what has been nominally construction but, even under foreign supervision, things do not move with a lightning speed in China. There are all sorts of complications and delays and so we have made very little progress so far and I am afraid that the completion of our little two hundred and fifty miles on this end is a long way in the future. Just between ourselves, I think that if we had a little American spirit of hustling things along and getting them done, we might be running some profit earning trains before long. But, of course, that would not do to say here.

On my return, I will, of course, be very glad to tell the students what I know about China and railroading here. Apparently, from the newspapers, it is something that will begin to interest American engineers before long, much more than it has in the past, if the American financiers do all that is claimed for them.

Frank E. Hermanns

To the Editor of the Tech:

My dear Sir—I have for many years taken an interest in the courses of study at the Institute and have watched the progress of the graduates with pleasure. On the whole I believe that the courses of study in the different Departments are well arranged. As a rule they occupy a position very near the average of the other leading Technical schools and Colleges which make a specialty of technical training. I mean by this that the number of hours devoted to the different courses are not very far fom the average of the other principal training institutions. If this is generally accepted as true it will go far towards dissipating the common belief that Technology pushes its students too severely.

As far as the quality of the instruction is concerned I believe that M. I. T. compares favorably with any other school.

I have had the good fortune to employ at different times a number of Technology graduates as well as those from other educational institutions and it has been my experience that men from M. I. T. are, when compared with others, well trained, bright, alert and ready for the different problems of the profession.

It would be almost invidious to pick out special courses for commendation, where all are animated by the spirit of ambition and emulation. It is delightful to consider in this connection that there can never be a "Trust" in Education.

As time goes on many more technical schools will spring up in different parts of the land. The more the better. There is room for all, but as far as we can see at present they will all have to hustle to show advantages over our own Technology.

Faithfully,
Desmond FitzGerald.

To the Editor of The Tech:

Answering your request made to some of the graduates of the Civil Engineering Department for accounts of their professional careers, I submit the following statement of my engineering work covering a period of sixteen years. The summer following my junior year was spent as transitman on surveys and designs for a water supply system. After graduation, in 1893, one year was given to a post-graduate course at the Institute, principally in structural, hydraulic and laboratory work, for which a Master's degree was granted in 1894. The summer of that year was devoted to structural drafting at the Boston Bridge Works. In 1895 I entered the employ of the Engineering Department of the City of Boston and have been engaged in municipal engineering work there ever since.

My work for the city began under the late John E. Cheney, the Assistant City Engineer, a man of the finest type and an engineer of thorough training and sound common sense who had come to be recognized as one of the foremost bridge engineers in the country. As draftsman and Assistant Engineer I was in responsible charge of bridge designing under Mr. Cheney from 1897 until his death, in 1906, since which time I have had charge of the design and construction of city bridges, reporting directly to the City Engineer. My city work has included the design, construction or reconstruction of over thirty municipal bridges built for the heaviest traffic (including in some instances steam and electrated railroad traffic) and costing several million dollars; the most important of these being the new Cambridge bridge, a three million dollar structure. Many of the bridges are over navigable tide-water and contain draw spans of one or another type. The Charlestown bridge draw span is the widest swing draw in the world and the Northern Avenue draw, slightly heavier than the Charlestown draw, is the heaviest movable span in New England. Unlike the experience usually gained in the service of a bridge company, this structural work has included foundations in tide-water and on land as well as bridge superstructures. In my work for the City of Boston I have had to deal with a variety of problems other than those of structural engineering, considerable time having been devoted to statistical work.

Mr. Cheney's reputation was such that he was frequently consulted by railroad and other corporations, and by individuals, upon various structural matters, and for eleven years, I was associated with Mr. Cheney in his consulting practice. This work included examinations and reports on existing bridges and the design of many new bridges for steam and electric railroad and highway uses throughout New England, involving tide-water and other foundation and draw spans; also, the design of cantilever and other foundations and the steel frame construction of many large buildings, the design of dams and of structures of reinforced concrete.

In addition to other duties I have, during the past twelve years, done a certain amount of consulting work on my own account, this independent practice having included bridge work for some Canadian railroads and for the Province of New Brunswick, and bridge structural building and foundation work in different parts of New England. In connection with the large ship lock of the Charles River Dam, I designed, for the contractors, the coffer-dam for unwatering two acres of the harbor bed, which structure resisted between forty and fifty feet head of tide-water; and for the same contractors, I made a design for a shut-off-dam about a thousand feet in length. A most interesting piece of work was that in connection with the building of the Washington Street tunnel, beneath the foundations of the Ames building, a massive masonry structure two hundred feet high, on which I served as consulting engineer for the owners of the building. Legal engineering and expert testimony have formed a part of my professional work.

The things which have helped me most, professionally, are: my undergraduate training at the Institute, my post-graduate course there, which was in many ways of greater value than the whole four undergraduate years, intimate association with able engineers like Professor Swain and the late John E. Cheney, and membership in professional societies, notably the American, Canadian and Boston Societies of Civil Engineers. I advise Tech men to join professional societies as soon as they are eligible and to mix with their fellow members, socially as well as professionally.

From my experience with men trained at other institutions and from some knowledge of teaching methods elsewhere, I am of the opinion that the course in structural engineering at the Institute has long been, and continues to be, the best to be had at any institution in the country.

Yours truly,
Frederic H. Fay

STRUCTURES

(Continued from page 5.)

the arrangement and the details of these members.

The post-graduate course is intended more especially for those wishing to specialize in structural engineering, and is open only to those who have finished the undergraduate course in Structures or who have taken its equivalent elsewhere. It deals with long-span bridges and arches, and with complicated types of structures for which more precise methods than those used for ordinary structures are needed.

In the class-room work in this subject the fact that Civil Engineering is an art founded upon comparatively few well-established basic principles is clearly recognized, and every effort is made to thoroughly establish these principles in the student's mind by frequent applications to varying and unfamiliar conditions. The practical side of the subject is also clearly presented and questions of cost, and of practice in field and shop are freely discussed. The value of the analytical character of the subject in the development of logical thinking is thoroughly appreciated, and the attempt is made to give to the course a high value as a source of mental discipline entirely aside from its practical value to the engineer.

CURRICULUM

(Continued from page 5.)

Railroad and Highway Engineering, Geology, Astronomy and Geodesy, which include both class and field work. The greater geological processes, erosion, sedimentation, deformation and eruption, are discussed in order by means of lectures, illustrated by maps, diagrams, specimens and stereopticon. Other lectures, illustrated by trips to places in the vicinity of Boston, consider the broader structural features of the earth's crust and the application of the principles of Structural Geology to practical problems of interest to the Civil Engineer. A course in Building Stones consists of a systematic laboratory study of the common rocks, alternating with illustrated lectures upon their application in engineering works. In connection with lectures in practical astronomy and geodesy as of interest to the surveyor, observations are made with the engineer's transit for latitude, longitude, time and azimuth.

The study, during the first term of the third year, of the strength of various materials of construction, including a mathematical discussion of shearing, bending and torsional stresses and strains in beams, columns, hooks, springs and riveted sections, furnishes an introduction to a course in the Theory of Structures in the second term. This course comprises a study of the loads, reactions, shears and moments acting upon structures of various kinds, principally roofs and bridges, and includes the practical designing of beams. Practise is also given in the testing laboratory in the actual determination of the strength of various materials. An elementary lecture course in Direct and Alternating Current Electric Machinery, designed to present the principles governing the utilization of electricity for power purposes, is also introduced.

In the comparatively advanced work of the fourth year, the student in Civil Engineering is offered a choice between two options or lines of study. The first, treating Civil Engineering in general, emphasizes more particularly the study of Hydraulic and Sanitary subjects. A condensed treatment of the drainage of buildings and lands and the disposal of sewage in cities and towns, gives a limited instruction in the principles of Sanitary Engineering. In the second option, more attention is devoted to Highways, Railroads and Railroad Management. In addition, courses, common to both options, are given in general Structures, Bridges and Bridge Design, Foundations, Theoretical Hydraulics and Steam Engineering, the latter dealing with valve-gears, steam-engines, power-station accessories, thermodynamics, and steam boilers. Laboratory instruction in Hydraulics and the testing of materials is also given.

The work in Structures comprises the computation and design of structures of wood, steel and masonry by analytical and graphical methods. The subjects considered are simple beams, plate girders, roof and bridge trusses of various forms, trestles of wood and steel, earth pressure, retaining walls, masonry dams, arches of metal, stone and concrete, and other reinforced concrete structures. The course in Foundations is devoted to the methods of constructing foundations for bridges and buildings, and to a study of the properties, manufacture and methods of use of concrete and various cements.

In the several courses treating of Hydraulics, the student is taught, partly by means of lectures and class work, and partly through direct experimental observation, the principles of hydrostatic and hydrodynamic pressure, the flow of water in open channels, through pipes and orifices, and over weirs, as well as the determination of losses from friction and other sources. There are also considered problems of water supply and power for cities and towns, including a computation of the necessary storage to insure a required amount of supply, the designing of dams, standpipes, conduits and distribution systems, modes of estimating the power capacity of water privileges, and elementary principles involved in water wheels and turbines.

The Railroad class work of the third year comprises a thorough study of

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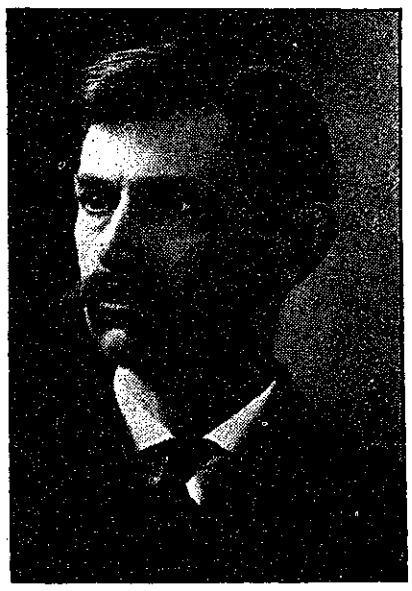
(Continued on page 10)

PROPOSED SUMMER COURSE

By Prof. A. G. ROBBINS.

The necessity for transferring the field-work in surveying to the summer has arisen from the changed conditions brought about by the extension of the thickly populated parts of the city, by the greatly increased size of the classes and by the crowded curriculum.

In the early days of the Institute of Technology there were a number of



PROF. A. G. ROBBINS.

tracts of unoccupied land within a few minutes' walk of the Institute buildings where surveying field-work could be efficiently taught. For several years, however, it has been necessary to teach a large part of surveying at places from eight to fifteen, and in some cases, twenty-five miles from the city. Much time is lost in travel, and thus the already too little time given to this important subject is greatly reduced.

In other ways the efficiency of the surveying field-work is impaired. The ever-increasing amount of subject matter which ought to be included in an Engineering Course, and the commendable ramifications of student activities, claim their share of the students' energy, so that few of them give the full measure, either of time or thought, needed for a working mastery of the art.

These are some of the reasons which have led to the recommendation that a course in surveying be required of students in Civil and Sanitary Engineering in the summer following the second year, a recommendation which the whole department feels should be speedily adopted or our surveying field-work will have to be reduced to laboratory exercises limited to the setting up and use of instruments.

This work can be most satisfactorily done, the writer believes, at a camp, the site for which should be so chosen as to afford opportunity for efficient teaching of plane, topographic, hydrographic, and geodetic surveying, railroad location, river gauging, and tidal measurements.

Such a location can, doubtless, be obtained. When this shall have been done the instruction in surveying given by Technology may be made superior to any now given here or elsewhere.

WORK OF ASSISTANTS

By MR. J. W. HOWARD.

The position of assistant in the Department of Civil Engineering may be considered temporary, as very few of the men remain longer than two years. For this reason it becomes necessary to fill these vacancies frequently. This is done by asking a number of the graduating class to return. Many advantages are offered to these men which they could not obtain if they entered directly into professional work. The duties of an assistant are not so confining as to prevent him from attending classes or engaging in a limited amount of outside work. There is a fine opportunity for advanced study, undergraduate work or a general review of his professional work. This may be done by attending classes or studying by himself. Whichever method is chosen there is always the opportunity for consulting men at the head of the profession. I cannot lay too much stress on the importance of reviewing one's work after graduation. This should be done to fix clearly in mind the work taken up at the Institute and to settle definitely any questions which there are about this work.

At graduation a great many men are in doubt as to what kind of work to enter. Returning to the Institute as an assistant gives these men an opportunity for further investigation before deciding this question. Information is readily obtained regarding the different kinds of work. If one returns as an assistant his decision need not be hasty.

A very important part of the assistant's duty is his instruction in field-work. All the assistants in Civil Engineering have this opportunity for teaching. The fieldwork consists of exercises in elementary surveying and topographical and railroad engineering. This is valuable to the assistant as it gives him the opportunity to look at this work from the standpoint of a teacher. In addition to teaching this work the assistant acts as chief of party in the field. Under his direction the work progresses in the same manner as it would if he were holding a similar position in an engineering office.

Another important advantage of which we must not lose sight is the closer contact with the professors. The assistant comes to know his former teachers far better than as a student. This better acquaintance obviously means better understanding. Right here I may add that besides being allied with these men he has an unusual opportunity of meeting other engineers.

Thus far I have mentioned only the advantages connected directly with the Institute. I now wish to mention a few of the advantages that may come to an assistant due to his position. There is more or less outside work in which an assistant may engage. This work comes from quite different sources and gives the assistant both responsibility and very varied experience. Several members of the department teach some engineering subject at evening schools. Often these courses are a combination of lectures, recitations and drawing-room work. There is no better training than this for one to learn how to present a subject in a clear and concise way .

INSTRUCTING STAFF

C. Frank Allen, S. B., Professor of Railroad Engineering, graduated from M. I. T. in 1872. He engaged in professional work until 1887, when he returned to take up teaching at the Institute, being made Assistant Professor at that time. Two years later he became Associate Professor and in 1896, was promoted to the rank of Professor.

During the fifteen years between graduation and returning to the Institute, Prof. Allen was gaining that wide experience and knowledge of the legal as well as the practical side of railroading which makes him so eminently fitted for the position at the head of the railroad engineering courses in the Civil Engineering department.

Upon graduation, he went to Providence, R. I. and was engaged for four years in water works and sewerage problems. He then went to Newton, Mass., where he was in charge of the construction of the open reservoir on Hammond St. near the Newton Boulevard. For a short time after the completion of this work he was connected with sewerage work in Boston.

In 1878, Professor Allen turned to newer and larger fields in the West. He went into the employ of the Atchison, Topeka and Santa Fe R. R., at Pueblo, Colo. During the years which he remained with this railroad he spent part of the time in office work, and part in construction work. For some time he was right-of-way agent.

Later at the suggestion of the railway, he began to study law and was admitted to practice. As a lawyer Professor Allen represented his railroad at Socorro, New Mexico, and also served for some time as City Attorney.

(Continued on page 4)

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BOSTON, MASS., DECEMBER 11, 1909.

Briefly, the purpose of the series of special issues on the Institute Departments, of which this is the first, is to make the various Courses more familiar, not only to the freshmen who have yet to choose their profession, but to the upper classmen, who though they may know their own Course fairly well, seldom know anything about the others. It is hoped, also, that the issues may be invaluable to many high school men who have yet to choose their life work and their Alma Mater.

The committee in charge takes this opportunity to thank the professors in the Departments of Civil and Sanitary Engineering, and Mr. Howard and Mr. Waller, for the articles they have so kindly written for these pages.

For the hearty co-operation of the Board of Editors of The Tech the committee is also duly grateful.

INSTRUCTING STAFF

(Continued from page 3.)

At one time in New Mexico, Professor Allen was chief engineer of the water works at Los Vegas, New Mexico, works costing about $100,000, and was also employed for a short time by the First National Bank at Los Vegas.

Since coming to the Institute, Professor Allen has done some outside work, but has devoted his best energies to the work of the Course.

He has been President at different times of the Boston Society of Civil Engineers, of the New England Railroad Club and of the Society for the Promotion of Engineering Education. He has been a member of the American Society of Civil Engineers since 1878.

Dwight Porter, Ph. B., Professor of Hydraulic Engineering, graduated from the Sheffield Scientific School of Yale University in 1880. In the fall of 1883, he came to the Institute as Instructor in first-year mathematics and assistant in first-year drawing. Two years later he was transferred to the department of Civil Engineering and, in 1887, became Assistant Professor. At the end of three years he was promoted to be Associate Professor and in 1896 became Professor of Hydraulic Engineering.

Immediately after his graduation from the Sheffield Scientific School, Professor Porter began a special investigation for the Tenth U. S. Census, of the water power resources of the more accessible streams of the United States. This was done under Francis A. Walker, who was afterward President of the Institute. Engaged in this work with Professor Porter were George F. Swain, afterward a professor in the Civil Engineering department of M. I. T. and head of the course until last year, and James L. Greenleaf of the Columbia School of Mines.

In 1887-88 Professor Porter made, with the aid of a number of students, a sanitary survey of certain tenement districts of Boston as a basis for improving their condition. He has been a member of the committee of three engineers for examining applicants for civil engineering positions under control of the Mass. Civil Service Commission.

Professor Porter has served as expert in a number of court cases and before legislative committees where hydraulic or sanitary questions were involved.

He is a member of the American Society of Civil Engineers, Boston Society of Civil Engineers, New England Water Works Association, Society for Promotion of Engineering Education, etc.

Charles Milton Spofford, S. B., Hayward Professor of Civil Engineering graduated from the Institute in 1893. The second term of the following school year he returned to take up a post-graduate course. In 1896 he came to the Institute as assistant in the department of Civil Engineering and remained on the instructing staff in various positions until 1903.

In 1905 he went to the Brooklyn Polytechnic Institute as professor of Civil Engineering.

In February of this year the Executive Committee of the Technology Corporation appointed Professor Spofford to the chair of Hayward Professor of Civil Engineering, left vacant by the resignation of Professor George F. Swain. Professor Spofford was asked to take charge of the instruction in structural engineering, in which branch he has specialized.

In 1894, after he completed his post-graduate course, Professor Spofford went to Phoenixville, Pa., to engage in the employ of the Phoenix Bridge Co., remaining with this concern until his appointment as Assistant at the Institute in 1896.

Professor Spofford has had a great deal of practical experience in his chosen branch of civil engineering, namely, structural work. During the summers of 1896-1903, while he was at the Institute, he was in the employ of the Engineering Department of the City of Boston, as assistant engineer upon the design of several well-known bridges as for instance, the Broadway, Atlantic Avenue and Northern Avenue bridges and upon a wide variety of structural work. Professor Spofford has done expert work for the Boston Elevated, having examined and reported upon reinforcements required to make several Boston bridges safe for the increasingly heavy street car traffic. This work included the design for reinforcing the Boylston Street bridge over the B. & A. R. R.

During his stay in Brooklyn, he was connected with Mr. C. W. Hudson of New York, in a most interesting, important and valuable piece of work. This consisted in an investigation of the strength of the Blackwell's Island bridge over the East River, a most difficult problem requiring the application of the highest principles of structural engineering.

Prof. Spofford is a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, the Brooklyn Engineers Club, and the Society for the Promotion of Engineering Education

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Alfred E. Burton S. B., Professor of Topographical Engineering, is perhaps best known to almost all Institute students in his capacity of Dean. Professor Burton is a graduate of Bowdoin College, Class of 1878. He came to the Institute in the fall of 1882 as instructor in Civil Engineering and also assisted in first year drawing courses. In 1884, he was made Assistant Professor and took charge of the second and third year surveying work. Professor Burton has been in charge of most of the Summer Schools of Surveying from 1888 to 1903. In 1906 he was promoted to his present rank of Professor of Topographical Engineering and became Dean in 1902.

After graduation he spent a few months as a land surveyor and then took an examination for the position of Topographical Surveyor on the U. S. Coast and Geodetic Survey. This examination included six months trial in the Coast Survey office in Washington. Among the four successful candidates at the end of this time, were Alfred E. Burton and Robert E. Peary, since Commander U. S. N. and a claimant for the discovery of the North Pole.

In 1882, Professor Burton was aid to Assistant Edward Herzesheimer, in a resurvey of Long Island Sound. It was in the fall of this year that Professor Burton was offered and accepted the position of Instructor at the Institute.

In the summer of 1886, with the assistance of two of the engineering students he made a survey for the Appalachian Mountain Club of Mount Moosilanke, N. H.

The organization and conduction of the scientific expedition to North Greenland in 1896 was under the direction of Professor Burton and was a result of the suggestion of his friend, Lieutenant Peary. Some valuable data on pendulum and magnetic observations were obtained.

To Professor Burton is due the honor of obtaining the geodetic observatory at Middlesex Fells, a most important addition to the instruction in Geodesy at the Institute. He organized the eclipse expedition to Georgia in 1900 and a similar expedition to Sumatra, the next year.

He is a member of the American Society of Civil Engineers.

Arthur G. Robbins, S. B., Professor of Topographical Engineering, graduated from M. I. T. with the Class of 1886. He accepted a position as assistant in the department of Civil Engineering the same year and in 1888 was made an instructor. In 1896 he was promoted to the rank of Assistant Professor, and again in 1906, to Associate Professor.

During the summers of 1901, and 1905 to 1909, Professor Robbins has been in charge of the Summer School of Surveying of the Institute of Technology.

In the vacations of other summers he has been employed in various positions, including work in the office of the Holyoke Water Power Co., Water Works Construction at Norway, Maine, etc. He has been Assistant to the Engineer of Maintenance of Way of the J. M. & I. R. R., Louisville, Ky., Surveyor and Draftsman with the Boston Manufacturer's Mutual Fire Insurance Co., and Assistant to U. S. Light-House Surveyor 1st and 2nd Districts, Boston, Mass.

George L. Hosmer, Assistant Professor of Civil Engineering, was a member of the Class of 1897. For the next three years he was assistant in the department of Civil Engineering and in 1900, became Instructor. In 1907, he was made Assistant Professor of Civil Engineering.

Professor Hosmer was a member of the M. I. T. eclipse expedition to Georgia in 1900, and the one to Sumatra the next year. In 1905 he went with the Carnegie Institute expedition to Labrador.

During the summer vacations, Professor Hosmer, has been connected with the Mass. boundary surveys, survey of Charles River, for the Charles River Dam Committee, N. Y. Water Supply, and surveys for the R. I. Metropolitan Park Commission.

Charles B. Breed, S. B., Assistant Professor of Civil Engineering, was graduated from the Institute in 1897. In 1898, he came back to the Institute as Assistant, was made an Instructor in 1900 and became Assistant Professor in 1907.

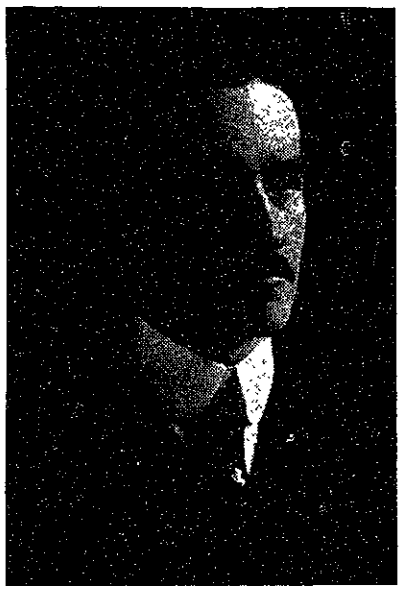
Previous to his graduation, Professor Breed worked in the civil engineering department of the City of Lynn, in the civil engineering department of the Boston & Maine Railroad, and in the department of masonry inspection of the Boston & Albany Railroad; this work being done during the summer vacations.

After graduation, he spent a year with the Boston and Albany, being concerned principally with the abolition of grade-crossings in Newton and Natick. For the next eight summers he was inspector of the Weston aqueduct of the Metropolitan Water Works and was also on the sewerage committee.

He has been inspector of dredging, on the Harbor and Land Commission, assistant engineer of the City of Lynn, assistant engineer of the Chicago and Western Indiana R. R., on track elevation in Chicago, resident engineer of the Walton Pond Dam of the City of Lynn and for the last five years consulting engineer in Lynn on the abolishion of grade-crossings. At the present time Professor Breed is consulting engineer for the work of elimination of grade-crossings at White River Junction, Vt., and also at Quincy Mass.

He is an associate member of the American Society of Civil Engineers, a member of the Boston Society of Civil Engineers, of the American Railway Engineering and Maintenance of Way Association, of the New England Railway Club and of the Society for the Promotion of American Railroad Engineering.

George E. Russell, S. B., Assistant Professor of Civil Engineering, graduated from the Institute with the class of 1900. The year immediately following his graduation he spent as assistant in the department of Civil Engineering here. At the end of this time he resigned to accept a position as designing engineer with the American Car and Foundry Co. of New York and was intimately connected with the development of the steel car until 1904.



PROF. GEORGE E. RUSSELL.

He then entered Cornell as a graduate student and also as Instructor in the department of Civil Engineering.

In 1905, he was secured by Professor Swain to fill a vacant instructorship at the Institute and in 1907 received promotion to the grade of Assistant Professor.

Professor Russell was connected with the Charles River Basin Commission in 1906, the Boston Transit Commission in 1907, when he conducted (with Professor W. E. Mott) an investigation of the congestion of traffic in Boston's streets, and in 1908 with the Metropolitan Improvements Commission as investigator of passenger transportation.

Professor L. E. Moore graduated from the University of Wisconsin in the Mechanical Engineering Course in 1900 and subsequently spent the year 1901-1902, studying in the Civil Engineering Department at the M. I. T. He was given the degree of Civil Engineer by the University of Wisconsin in 1906, for certain professional and experi-

PROF. LEWIS E. MOORE.

mental work done after graduation.

The positions he has held in educational work were: instructor in mechanics and structural engineering in the University of Wisconsin for one year and instructor in theoretical and applied mechanics, in the University of Illinois for three years. From October, 1907 to date he has been Assistant Professor of Civil Engineering in the Massachusetts Institute of Technology, teaching bridge design, foundations and third year structures.

The following is a brief outline of the practical work he has done. He was employed as Master Mechanic for the Champion Iron Mining Company

(Continued on page 5.)

HISTORY OF COURSE I

(Continued from page 1.)

of President Walker may have entered into this, the writer is unable to state. The Geodetic Option was carried on for a number of years with very satisfactory results. Graduates in this option have secured excellent positions and have done splendid work. The field for men thus specially trained is not large, and it has seemed wise finally to have work of this kind pursued as graduate advanced work upon a strong engineering foundation. The opportunities are excellent for the pursuit of this line of advanced work; there is an observatory in the Middlesex Fells available, which belongs to the Institute, and Professor Hosmer is well qualified by taste and acquirement to attend to the special studies of this option. In 1887, Professor Allen entered the Department as Professor of Railroad Engineering, and his work has been for some years confined to that specialty; except for one advanced course in Specifications and Contracts.

In 1888, it seemed necessary that Bridge Design should have the attention of a special instructor, and J. H. Stanwood first undertook this work. Upon his death, in 1896, Professor McKibben assumed charge of the class and during the years in which he and Professor Spofford were associated in this work, the instruction in Bridge Design was brought to a high state of efficiency which it still maintains under Professor Moore and Mr. Bradbury. With larger classes it became impossible for one man to do the class work in Structures and the Third Year work was turned over to Professors McKibben and Spofford, the class being divided into two sections; and for two or three years past, divided into four and smaller sections, Professors Mott, Russell and Moore, and Mr. Bradbury carrying on this work. The instruction in Hydraulics too must be given to larger classes, and also to students in other courses, Mechanical, Electrical, Mining, Chemical and Chemical Engineering. Professors Mott and Russell for the last two or three years have spent their efforts largely in this direction while Professor Porter has also continued in teaching Hydraulics. Professor Mott's withdrawal has led to the appointment of Professor Barrows, fresh from successful experience in practice, and with familiarity in teaching acquired at the University of Vermont, and previous service as Assistant at the Institute. Professor Russell has recently published an admirable book on Hydraulics, well adapted to Institute work. The ability displayed by him in this way stands to the credit of the department, and the hydraulic work under Professors Porter, Barrows and Russell is upon a strong basis. In Railroads also, the size of the classes has brought Professor C. B. Breed into the class work of teaching as well as control of the railroad field-work, and this has added material strength to this part of the work.

In the old days the Surveying was satisfactorily successful with smaller classes under such experienced men as Professors Burton and Robbins, when the work could be handled close by. With larger classes, and with the necessity for going farther into the country, less effective work is possible, and it is expected that a Summer School of Surveying will be established at which practically all of the field work will be accomplished. Much of the preliminary work to this end is already done, and that a speedy and favorable outcome will result is confidently expected. This is today the greatest need of the Department. It is needed as much for the Railroad work of the Third Year as for the Surveying of the Second year and will also simplify the Hydraulic field work.

In 1890, and for several years later, through means furnished by Colonel A. A. Pope of Boston, well known for his interest in "Good Roads," additions were made to the Museum, Library and Laboratory, in the direction of Highway instruction, and a special Instructor was secured. Much of the course in Civil Engineering, in Railroads and otherwise, is and has been applicable to highway construction, but a special course in Highway Engineering is still mantained.

Several years ago it was found that the increase in entrance requirements released an appreciable amount of time at the top, in the Fourth Year. The Department was well united in believing that an adequate course in Steam Engineering would add greatly to the strength of the Course in Civil Engineering. The course in Steam has from time to time been strengthened to the point where its sponsors believe it to be definitely better than the course given even to Mechanical Engineers twenty or twenty-five years ago. A pumping engine for the hydraulic or sanitary engineer, or the locomotive for the railroad engineer, should certainly not be beyond his ken. A course in Dynamo Electric Machinery leaves the student not without some knowledge of electricity, the importance of which is becoming daily more evident.

During Professor Swain's administration, not only has the work of the course developed, and the Department grown to its present size, five Professors, one Associate Professor, four Assistant Professors, two Instructors, and eight Assistants, a total of twenty; but there has been a physical development as well. During this time the hydraulic laboratory, now operated by the Mechanical Department, was installed from the Civil Engineering side. It includes a large tank for measuring the flow from orifices, a standpipe allowing about eighty feet of head, with weirs, nozzles, water wheels, and pumps. There are also in the department, floats and various forms of current meters, for determining the flow of streams. The laboratories of the Mechanical Department are regularly used by students of Civil Engineering for experiments in Steam, and in Applied Mechanics for testing materials, and are especially available for Thesis work. The observatory in the Middlesex Fells has already been referred to.

From time to time students have seen fit to take advanced work, post-graduate work, but until a year ago, only graduates from the Institute courses entered upon this work, and then at intervals. The course in Civil Engineering now seems developed to a point where a regular demand for the post-graduate work exists, both among our own graduates and students from other colleges. The Department at this time seems well equipped to give such work, and progress in this direction can not only be expected but also will be welcomed.

The library of Civil Engineering books was in 1886 of insignificant size, possibly two hundred books. In some respects the greatest monument to Professor Swain's labors here, is the splendid Library, the result largely of his diligence and skill, a library of Civil Engineering without a superior in the United States; its standard must be maintained.

INSTRUCTORS AND ASSISTANTS, 1909-10.

The collection of framed photographs in the hallways and the drawing rooms has a wide reputation. Other acquisitions less in evidence are albums of photographs of railroads, highways, bridges, canals, and various engineering works, gathered from all over the world, supplemented by a notable collection of lantern slides. A museum of less pretence nevertheless contains not a little of value, somewhat less accessible than desirable on account of restricted space.

Upon Professor Swain's retirement, a re-arrangement has been made of the work of the Department of Civil and Sanitary Engineering, and of the courses in Civil Engineering and of Sanitary Egineering. In Civil Engineering Professor Spofford represents the Course in all matters connected with Faculty or Students, and Professor Porter assumes the same relation to the Course in Sanitary Engineering. The Department of Civil and Sanitary Engineering in its general and administrative relations is represented by Professor Allen. Furthermore, it is contemplated that the powers and the initiative of Professors Porter, Robbins, Spofford and Allen, dealing with work in Hydraulics, Surveying, Structures and Railroads, shall be somewhat greater than heretofore. The scheme seems somewhat more democratic than the former, and meets with favor among members of the department generally, and with the present personnel at least, is sure to work satisfactorily.

Such, then, appears to be the development of the department. In it Professors Henck, Vose, and Swain has each had his conspicuous and important part. To Professor Henck for his work at the beginning too much credit cannot be given; the writer who was a student under him still feels under a heavy burden of debt to him. Respect and admiration go out to him. For Professor Vose, personally, the writer has most pleasant remembrances although not associated in his work. For Professor Swain more than twenty years of association leave a feeling not only of high appreciation as teacher and engineer, but also of personal affection. His work here is not likely to be underestimated by those who knew him.

At first thought the departure of Professor Swain and Professor Mott have seemed an irreparable loss; but we look forward not backward. Professor Spofford and Professor Barrows, both former members of the Department, return to us after a well-rounded experience both in teaching and in practice, in the prime of life, ready and able to do splendid work for many years to come, not only in undergraduate but in advanced work especially.

Great credit is due to Professors Henck, Vose and Swain for the department which they have built up. To take up the burden laid down by them is no idle task, but with the support of a united and enthusiastic department Professor Porter, Professor Robbins, Professor Spofford and the writer assume the load without flinching; the standard of the department will not be allowed to drop.

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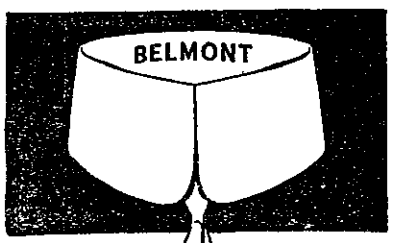

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CURRICULUM

(Continued from page 6)

curves and earthwork and their application in the location and construction of a railroad. The fieldwork of the first term consists of a survey for a railroad some two miles in length. The reconnaisance is followed by the preliminary and later the location survey. Upon the completion of the fieldwork the line is plotted from the notes taken. In the second term the work consists of the laying out of various curves and the staking out of earthwork. Practise is given in the drawing-room in adjusting a line of railroad to a contour map, with computation of the "cut and fill" and "haul." An investigation into the economics of railroad location, including train resistance and the influence of grade, distance, curvature and rise and fall, together with a study of rolling stock, power-brakes and signals, yards, stations and tunnels, comprises the class-work of the fourth year. In the drawing-room practical problems are given in contour location, the proportioning of culverts and waterways, the design of track-work, yards, station-grounds, interlocking signals, etc.

Only a portion of the third-year work, and none of the fourth-year work, is all that is required in Railroads of the students in Sanitary Engineering. There is also a considerable reduction in the work required in Bridges and Bridge Design. The time gained is, as previously stated, devoted to courses in Chemistry and Biology. In these it is designed to give the students such training as shall fit them to interpret properly the results of researches in Sanitary Chemistry and Sanitary Biology, and to co-operate with chemists and biologists in professional work.

Practise is given in the third and fourth years in the Chemical and Biological laboratories. The student is instructed in the methods of Water and Air Analysis, and is taught to observe and identify the various vegetable and animal organisms present in natural water and sewage. The course devotes particular attention to the sanitary side of questions of water supply and drainage, and discusses, among other things, the principles of filtration and the methods of purifying water and sewage, the relation between drinking water and disease, methods of disposal of sewage, and other problems relating to the health of communities.

Thus, while the course in Sanitary Engineering is fundamentally a course in Civil Engineering, though a somewhat abbreviated one, sufficient instruction in Chemical and Biological subjects is imparted to the student to enable him to deal successfully with many problems of modern city life in which the student in Civil Engineering has had practically no training.

In addition to the above courses, opportunity is given for a considerable amount of advanced work after graduation, which is described in another column. A comparatively new departure is the institution of a five-year course, which allows the student to complete the work of both the Sanitary and Civil Engineering courses, a separate degree of S. B. being conferred in each department.

Besides the purely engineering subjects thus far mentioned, there are also splendid opportunities for work along more academic lines. Courses in English composition and literature and in English and American history during the first and second years, Political Economy and a choice of several options in Economics, English, Modern Languages or History during the third year, together with Business Law in the fourth year, are made a part of the requirements for the students in all departments. Additional electives in all of these subjects are also available.

The Institute Civil Engineering library is one of the best, if not the best, in the country. Complete and up-to-date in every detail, it contains about 1,100 volumes, including German, French, and Spanish texts, that cover the entire engineering field. All periodicals of importance are taken, foreign and domestic, and pamphlets and reports of engineering societies are received.

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